

CLAIMS

What is claimed is:

1. A heat exchanger comprising:
 - a substantially rectangular cover plate having a plurality of openings
 - 5 that include a liquid inlet opening positioned proximate to a first side of the cover plate and a liquid outlet opening positioned proximate to an opposing side of the cover plate and a gas inlet opening positioned proximate to a second side, adjacent to the first side, of the cover plate and a gas outlet opening positioned proximate to an opposing side of the cover plate;
 - 10 a substantially rectangular upper plate having a plurality of openings that include a liquid inlet opening positioned proximate to a first side of the upper plate and a liquid outlet opening positioned proximate to an opposing side of the upper plate and a gas inlet opening positioned proximate to a second side, adjacent to the first side, of the upper plate and a gas outlet
 - 15 opening positioned proximate to an opposing side of the upper plate, wherein the gas inlet opening forms a seal with the gas inlet opening of the cover plate and the gas outlet opening forms a seal with the gas outlet opening of the cover plate to prevent gas flow into a liquid flow space defined by and between the cover plate and the upper plate;
 - 20 a substantially rectangular lower plate having a plurality of openings that include a liquid inlet opening positioned proximate to a first side of the lower plate and a liquid outlet opening positioned proximate to an opposing side of the lower plate and a gas inlet opening positioned proximate to a second side, adjacent to the first side, of the lower plate and a gas outlet
 - 25 opening positioned proximate to an opposing side of the lower plate

wherein the liquid inlet opening forms a seal with the liquid inlet opening of the upper plate and the liquid outlet opening forms a seal with the liquid outlet opening of the upper plate to prevent liquid flow into a gas flow space defined by and between the upper plate and the lower plate; and

5 a substantially rectangular bottom plate.

2. The heat exchanger of claim 1, further comprising substantially rectangular openings.

10 3. The heat exchanger of claim 1, further comprising one or more gas flow headers having substantially circular and substantially rectangular cross-sectional areas.

15 4. The heat exchanger of claim 1, further comprising one or more liquid flow headers having substantially circular and substantially rectangular cross-sectional areas.

20 5. The heat exchanger of claim 1, further comprising gas flow headers having substantially circular and substantially rectangular cross-sectional areas and liquid flow headers having substantially circular and substantially rectangular cross-sectional areas.

6. The heat exchanger of claim 1, wherein the seals comprise brazed seals.

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7. The heat exchanger of claim 1, wherein the cover plate, the upper plate, the lower plate and the bottom plate comprise stainless steel.

8. The heat exchanger of claim 1, further comprising flow
5 partitions positioned in the gas flow space.

9. The heat exchanger of claim 1, further comprising flow partitions in the liquid flow space.

10 10. The heat exchanger of claim 1, further comprising flow partitions in the liquid flow space and flow partitions in the gas flow space.

11. The heat exchanger of claim 1, further comprising surface indicia on one or more of the plates that act to increase surface area of the
15 one or more plates.

12. The heat exchanger of claim 1, further comprising surface indicia on one or more of the plates that act to increase turbulence of liquid flow or gas flow in the liquid flow space or gas flow space, respectively.

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13. The heat exchanger of claim 1, wherein the liquid flow space has a cross-sectional area and a height sufficient to maintain an average Reynolds number of greater than or equal to approximately 2000 for a liquid flow rate to the liquid flow space of greater than or equal to
25 approximately 160 ml per second.

14. The heat exchanger of claim 1, further comprising one or more additional upper plates.

5 15. The heat exchanger of claim 1, further comprising one or more additional lower plates.

16. The heat exchanger of claim 1, further comprising one or more additional upper plates and one or more additional lower plates.

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17. The heat exchanger of claim 1, wherein the substantially rectangular cover plate, the substantially rectangular upper plate, the substantially rectangular lower plate and the substantially rectangular bottom plate have a widthwise dimension that varies with respect to a
15 lengthwise dimension.

18. The heat exchanger of claim 17, wherein, upon operation of the heat exchanger, the lengthwise dimension aligns substantially with the Earth's gravitational force.

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19. The heat exchanger of claim 1, further comprising curved substantially rectangular plates.

20. The heat exchanger of claim 1, wherein the liquid flow space serves as a gas flow space and the gas flow space serves as a liquid flow space.

5 21. The heat exchanger of claim 1, wherein the gas inlet connects to a conduit to receive exhaust gas from an internal combustion engine.

22. A heat exchanger comprising:

a substantially circular cover plate having a plurality of openings that
10 include a liquid inlet opening positioned substantially opposite a liquid outlet opening and a gas inlet opening positioned substantially opposite a gas outlet opening;

a substantially circular upper plate having a plurality of openings that include a liquid inlet opening positioned opposite a liquid outlet opening
15 and a gas inlet opening positioned opposite a gas outlet opening, wherein the gas inlet opening forms a seal with the gas inlet opening of the cover plate and the gas outlet opening forms a seal with the gas outlet opening of the cover plate to prevent gas flow into a liquid flow space defined by and between the cover plate and the upper plate;

20 a substantially circular lower plate having a plurality of openings that include a liquid inlet opening positioned opposite a liquid outlet opening and a gas inlet opening positioned opposite a gas outlet opening, wherein the liquid inlet opening forms a seal with the liquid inlet opening of the upper plate and the liquid outlet opening forms a seal with the liquid outlet

opening of the upper plate to prevent liquid flow into a gas flow space defined by and between the upper plate and the lower plate; and

a substantially circular bottom plate.

5 23. The heat exchanger of claim 22, wherein the seals comprise brazed seals.

 24. The heat exchanger of claim 22, wherein the liquid flow space serves as a gas flow space and the gas flow space serves as a liquid flow
10 space.

 25. The heat exchanger of claim 22, wherein the gas inlet connects to a conduit to receive exhaust gas from an internal combustion engine.

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 26. A heat exchanger core comprising:

a substantially rectangular cover plate including a fluid inlet opening positioned proximate to a side of the cover plate and a fluid outlet opening positioned proximate to an opposing side of the cover plate;

20 a substantially rectangular upper plate including a fluid inlet opening positioned proximate to a side of the upper plate and a fluid outlet opening positioned proximate to an opposing side of the upper plate, wherein the fluid inlet opening substantially coincides with the fluid inlet opening of the cover plate and wherein the cover plate and the upper plate define a fluid
25 flow space between the cover plate and the upper plate;

a substantially rectangular lower plate including a fluid inlet opening positioned to a side of the lower plate and a fluid outlet opening positioned proximate to an opposing side of the lower plate, wherein the fluid inlet opening forms a seal with the fluid inlet opening of the upper plate and the
5 fluid outlet opening forms a seal with the fluid outlet opening of the upper plate to prevent fluid flow into an exterior flow space defined at least partially by and positioned at least partially between the upper plate and the lower plate; and

a substantially rectangular bottom plate.

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27. The heat exchanger core of claim 26 wherein the fluid inlet openings form a fluid flow shaft.

28. The heat exchanger core of claim 27, wherein the fluid flow
15 shaft comprises a fluid flow shaft having a major axis substantially normal to the cover plate, the upper plate, the lower plate and the bottom plate.

29. The heat exchanger core of claim 26, wherein the seals
comprise brazed seals.

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30. The heat exchanger core of claim 26, wherein the cover plate, the upper plate, the lower plate and the bottom plate comprise stainless steel.

31. The heat exchanger core of claim 26, wherein the cover plate, the upper plate, the lower plate and the bottom plate comprise one or more convex sides.

5 32. The heat exchanger core of claim 26, wherein the cover plate, the upper plate, the lower plate and the bottom plate comprise arcuate and convex widthwise sides.

33. The heat exchange core of claim 27, wherein the shaft resides
10 at least partially within an area defined by a convex side.

34. The heat exchange core of claim 26, further comprising a basket wherein the core is positioned at least partially within the basket.

15 35. The heat exchange core of claim 34, wherein the cover plate forms a seal with an edge of the basket.

36. The heat exchange core of claim 34, wherein the basket has a plurality of openings.

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37. The heat exchange core of claim 36, wherein the plurality of openings include an inlet opening and an outlet opening for access to the exterior fluid space.

38. The heat exchange core of claim 34, wherein the core has convex widthwise sides and the basket includes concave basket ends that complement the convex widthwise sides.

5 39. The heat exchange core of claim 38, wherein the basket ends reduce eddy formation proximate to an inlet opening of the basket.

40. A heat exchanger comprising:
a heat exchanger core having a core side fluid space and a cover
10 plate; and
a substantially U-shaped wall fitted at one end with an inlet header and, at an opposing end, with an outlet header, which, in combination with the cover plate, define a shell side fluid space.

15 41. The heat exchanger of claim 40, wherein the cover plate forms two seals with two opposing sides of the substantially U-shaped wall, forms a seal with the inlet header and forms a seal with the outlet header.

20 42. The heat exchanger of claim 41, wherein the cover plate defines a core side fluid space with an upper plate of the heat exchanger core.